Project Title: Cooperative Gust Sensing and Suppression for Aircraft Formation Flight

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Abstract:

Autonomous formation flight is an enabling technology for many future concepts of operations involving both manned and unmanned aircraft. Its potential benefits include energy saving and improved aircraft coordination within a high density airspace. However, with the following aircraft constantly flying in the leader's wake, several technical challenges need to be overcome before commercial aircraft and Unmanned Aerial Vehicles (UAVs) can routinely and safely fly in formation. Many challenges are related to the modeling, prediction, and real-time sensing of the dynamic airflow field, which includes both ambient and wake-induced wind gust disturbances. The objective of this overall research effort is to develop and experimentally validate a cooperative strategy for gust sensing and suppression within a close formation flight setting. During the Phase I effort, a real-time wind estimation algorithm was developed and evaluated with fight data; the concept of cooperative wind sensing was validated in simulation studies; autonomous close formation flight experiments with a five wing span (12 m) separation were achieved using two sub-scale research aircraft; and the effects of the wake vortices were successfully recorded by sensors onboard the follower aircraft. During the Phase II effort, refinement to the wake encounter models, the gust/wake estimation algorithms, testbed aircraft and avionics, and relative navigation algorithms were performed, which will lead to performing in-flight cooperative gust sensing and suppression control experiments.